STUDIES ON THE ETHER-SOLUBLE SUBSTANCES ON THE HUMAN SKIN

I. Quantity and "Replacement Sum"*

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INTRODUCTION

In spite of recent substantial progress in the methods used for quantitative assays of ether-soluble substances on the skin, further improvement of the technics appeared desirable.

S. Emanuel (1) and subsequent investigators, (e.g., E. O. Butcher and J. P. Parnell (2), E. Kirk and S. A. Kvorning (4, 5)), assayed specimens collected with ether poured into a glass cylinder on the skin surface, but failed to fully appraise the influence of accidental touching or wiping of the test site during the period preceding the examination. Moreover, the analytic methods of lipid determination of these authors are too intricate for most clinical laboratories; in addition, some of their methods are based on arbitrary standards, or indirect calculation.

Likewise, the procedure of G. Miescher and A. Schoenberg (6), who collected the waxes by means of filter paper kept in place by a rubber band, appears to us to involve several disadvantages. The failure of the filter paper to completely absorb all the ether-soluble material may result in deficient collection; and the long periods of sampling under pressure, as well as the local increase in temperature and humidity are liable to artificially alter the delivery of ether-soluble material.

For these reasons, we attempted to utilize the advantages and to avoid the disadvantages of the previous procedures by a modified method which included some of the technics of both groups of investigators.

The studies which are dealt with in this report were undertaken because it appeared that there was an urgent need not only for clarification of some of the previous findings, but also for further investigations of the amount of ether-soluble substances on the skin. The *first part* of the present communication is devoted to these problems.

Moreover, early investigations (13–15), as well as several of our own recent findings, stimulated our interest in the problem of a possible relationship between sweating and the presence of lipids on the skin surface. This question will be considered in the *second part* of this report.

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PART I

A. *Technics for Assaying Ether-Soluble Substances on the Skin Surface*

1. *Method of Collecting Samples.*

After extensive preliminary trials, ether collection in a special glass "cylinder", somewhat similar to the procedure employed by S. Emanuel (1), E. O. Butcher and J. P. Parnell (2) and by E. Kirk and S. A. Kvorning (4, 11), appeared most expedient. One half of the glass receptable is a cylindrical stem (see Fig. 1) open at both ends. The other half is an open glass hemisphere, much wider than the stem. The cylindrical stem opens with one end into the center of the convexity of the hemisphere. The edge of the wide opening of the hemisphere is molded, not unlike the edge of the common eye cup, to permit tight application to the skin surfaces. Receptacles of different size are used, depending on the size and configuration of the skin area under test.

The wide opening of the smallest container we employed has a diameter of 3.56 cm. and covers an area of 10 cm.^{2}; the diameters and surface areas of the wide openings of the larger

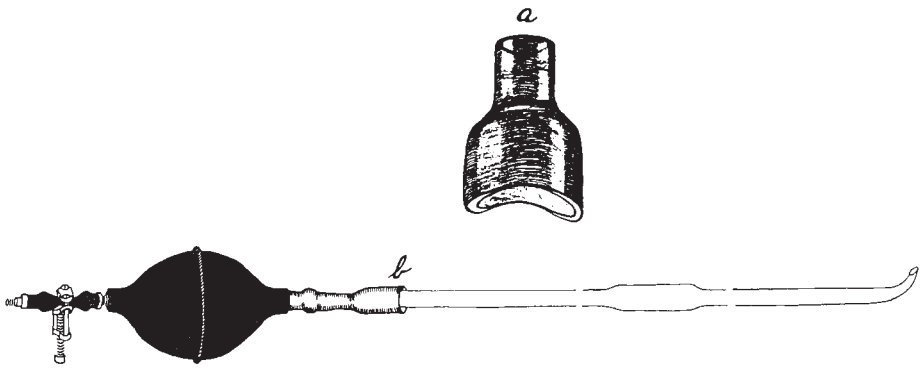

FIG. 1. a. Glass receptacle; b. armed pipette. For collection of ether-soluble substances on the skin.

receptacles are 4.36 cm. and 15 cm.^{2}; and 5.0 cm. and 20 cm.^{2}, respectively. While the receptacle is held with firm pressure on the test site, 7.5 cc. of fat-free ether are pipetted into the hemisphere on the skin. After 30 seconds, the ether is collected by means of a special pipette which is slightly drawn out and curved at its distal end (see Fig. 1); the other end is armed with a rubber ball for suction and compression. The collected solution is transferred into an aluminum foil dish.* The ether is replaced in the receptacle on the skin in immediate succession with 7.5 cc. and thereafter with 5.0 cc. Each of these samples is transferred with one and the same pipette. The three samples are pooled in the aluminum foil dish.

That the removal of ether-soluble material by this procedure is practically complete, was demonstrated by the fact that only occasional traces of dissolved material were found in the second ether sample, and only very rarely were there any traces in the third sample.

Addition of alcohol to the collecting ether resulted in solution of a smaller quantity of material than the use of ether alone. This finding stands in contrast to the assumption of E. O. Butcher and J. P. Parnell (2).

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* Ordinary weighing glasses and containers other than the aluminum dishes were found to cause errors, being too heavy in proportion to the small order of magnitude of the weights of the residues under investigation.

The aluminum dishes used are manufactured by the Central Scientific Co., Chicago, Illinois.

2. *Assay of the Quantity of Ether-Soluble Substances.*

The dishes containing the samples are placed on an electric heating unit, thermostatically controlled at 40°C., and the ether is allowed to evaporate slowly. Evaporation is completed in two hours. The dishes are then placed in a desiccator for about one hour, after which they are weighed on an analytical scale. It is self-evident that the quantity of ether-soluble substances is represented by the difference between the weight of the dish after evaporation and the precedingly ascertained weight of the empty dish.

Numerous control experiments were performed, in order to determine the validity of the relatively simple method. Many pooled samples were divided into several equal portions for parallel assays. There was satisfactory agreement of the results. In addition, parallel assays were carried out in which one part of a sample was evaporated after filtering with suction through a fritted glass filter, while an equal volume was subjected only to evaporation. Filtration of samples through a porcelain disk was adopted by E. Kirk (4) to remove any particulate matter from the skin which might have been suspended in the ether and erroneously have increased the weight of the residue. Our experiments failed to provide evidence of any significant retention of material by the filter, so that filtration was considered unnecessary.

A number of components may be present and weighed with the residue, which are not included in the calculation of nephelometric lipid analyses. Such substances are lipoproteins, certain phospholipids, and even certain complex electrolytes. Not all components of the residue, therefore, necessarily belong to the fats in a strict chemical definition. This fact, however, is apt to supplement, rather than disturb an assay designed to measure the complete amount of ether-soluble substances constituting the natural "waxy" coat on the skin.

3. *Preparation of the Test Sites and Definition of Levels.*

During the 24 hours preceding the tests, the test sites were neither washed nor permitted to come in contact with water, toilet articles, etc. Studies were carried out with one or more of the following three procedures:

a). *No artificial preparation of the test site.* The sites were not artifically protected. Therefore, accidental touching and wiping, contact with clothing and bedding, etc., were *not* prevented.

The amount of ether-soluble substances subsequently obtained was designated by us as the "unprotected" or "*casual level.*"

b). *Special protection of the test site.* The sites were protected from all contacts for 24 hours prior to examination.

This was done by fixing in position a windowed rubber sponge,* either ring-shaped, with a diameter of about 2.5″, for single test sites; or rectangular, about 6.75 x 8″, for two neighboring sites. Circular holes were cut in these pads, large enough to admit undisturbed application of our collecting receptacles to the skin. The pads were kept in place by adhesive tape, and on the forehead, in addition, by ties. Two wide strips of adhesive tape were crossed over the outside of the holes, which otherwise remained open. In order to prevent contact of resinous material with the test site, the under surfaces of the strips were carefully covered with adhesive tape, so that the non-adhesive surface faced the skin; and the edges were bound with scotch tape. Preceding the examination, the crossed strips were carefully removed to permit access of the cup to the skin. After the tests, the sponge was removed. Most of the volunteers wearing this protection were ambulatory.

* Rubber sponge-pads measuring $10\frac{3}{4}$″ x 8″ x $\frac{1}{2}$″ were found suitable. These pads are frequently used in household work for protection of the knees (e.g. during floor washing) and are obtainable in hardware stores.

The amount of ether-soluble substances on the protected areas was regarded as the "*protected*" or "*total level.*"

c). *Wiping of the test site.* Procedures a) and b) had revealed that one part of the ether-soluble material was removed from the skin by ordinary contacts, whereas another part apparently resisted these influences. Because of this finding, the sites being prepared by procedures a) or b) were wiped in a standardized manner with a dry muslin cloth, prior to the collection.

Four thicknesses of the cloth were wrapped and tied around the lower end of a wide test tube with a flat bottom. A fresh cloth and a clean tube were used for each wiping. The wipings were performed (always by the same persons) under moderate pressure, three times for 10 seconds each and at intervals of 20 seconds.

Whatever amount of ether-soluble substances was still found *after wiping*, we designated as the "*retained level*" or "resident —" or "residual —" or "adherent level."

4. *Repeated Collections at Short Intervals Following the Original Removal.*

After removing the ether-soluble material as described in procedures a), b) or c), the amount of ether-soluble substances newly delivered to the surface of the particular skin area was assayed at regular intervals, in a manner somewhat similar to the approach of a number of earlier investigators (1, 2, 6, 7, 12). The data already on hand (12) suggested that it might be advantageous to repeat the removals at intervals shorter than those employed by most previous investigators. Hence, we repeated the collections at half-hourly or hourly intervals over a period of two hours. In some instances collections were made only once at the end of the two hours. Half-hourly collections during the two hours following the original removal were eventually found to be most suitable for our purpose.

The sum of these half-hourly collections for a total of two hours will be referred to as the "*replacement sum.*"

When the palms (areas with no sebaceous glands) were studied, special procedures were introduced which were designed to reduce or exclude contamination of the palmar surface with sebaceous products from other skin areas. For this purpose, the dorsum of the hand, the fingers, and the distal part of the forearm, after thorough cleansing, were carefully painted with an aqueous solution of methylcellulose, or with collodion, prior to the examination, in order to effect occlusion of the follicular openings. In other experiments the dorsal surfaces of the hand and the other contiguous areas having sebaceous glands were thoroughly wiped with ether before, and throughout the course of the investigation.

B. *Subjects*

At present, a total of *1215* collections and assays have been performed with the described procedure, in 26 healthy males and six healthy females, ranging in age between 21 and 58 years. Twenty-three of the 32 subjects were between 21 and 25 years of age.

C. *Findings and Inferences From the Results*

1. *Levels.*

a). *The "casual level" (i.e. sites neither deliberately protected nor deliberately wiped).* As an example of the manner in which the mean "casual level" was

obtained in different areas of the body surface, Table 1 shows all the "casual levels" obtained in the temporal areas. The mean value was 1.77 mgm/10 cm.²*

Table 2 demonstrates the "casual levels" as assayed at different skin sites.

In *most* instances the ether-soluble substances collected from symmetrical sites were *equal in amount*. It is, however, noteworthy that in *three of the 32* test subjects, there was a *consistent divergence* in the quantities of ether-soluble substances collected from symmetrical sites.

TABLE 1

"Casual level" of ether soluble substances

Temporal areas

SUBJECT	RIGHT mgm/10 cm.²			LEFT mgm/10 cm.²		
	No. of tests	Average weight	Range	No. of tests	Average weight	Range
P. P.	12	*1.36*	0.90–2.05	12	*1.16*	0.90–1.6
H. R.	5	*2.00*	1.70–2.15	6	*1.86*	1.60–2.15
R. A.	3	*2.59*	2.10–2.65	3	*2.12*	1.90–2.35
E. O.	4	*1.69*	1.50–2.50	3	*1.80*	1.50–2.40
S. K.	4	*2.88*	2.40–3.30	5	*2.96*	2.15–3.60
J. K.	2	*1.68*	1.45–1.90	3	*1.60*	1.40–1.90
W. V.	1	*2.40*	—	1	*1.54*	—
W. S.	1	*1.00*	—	1	*1.25*	—
A. C.	5	*1.63*	0.80–2.40	3	*1.60*	0.90–2.10
F. K.	2	*1.12*	0.95–1.30	1	*1.15*	—
A. J.	3	*1.90*	1.40–2.80	3	*2.08*	0.95–2.90
H. G.	2	*2.18*	2.05–2.30			
R. S.	1	*1.10*	—	1	*1.45*	—
G. G.	1	*2.30*	—	1	*1.95*	—
L. M.	1	*2.10*	—	1	*1.70*	—
J. D.	1	*1.80*	—	1	*1.75*	—
S. C.	1	*1.50*	—	1	*1.75*	—
I. M.	1	*1.45*	—	1	*1.45*	—

Mean, in 18 subjects: 1.77 mgm/10 cm.²; s. d.: ±0.41.

Discussion

Our findings on the temporal areas are in agreement with those of the majority of previous investigators. Thus, E. O. Butcher and J. P. Parnell (2), as well as J. E. Pritchard, L. D. Edwards, J. E. Christian (10), obtained figures in the same range; and even the levels found by G. Miescher and his Swiss group (6, 7), who applied a special device to protect the forehead against contact for 22 hours prior to the test, were very close to our presented value. The figures of S. A. Kvorning (11) were somewhat higher than ours, those of E. Kirk (4) substantially higher, whereas S. Emanuel (1) arrived at lower figures.

* The temple was the only site on which the receptacle with the aperture covering 10 cm.² was employed. In all other areas tested, the larger receptacles were used, almost invariably that with the opening of 20 cm.² However, the values throughout this publication are uniformly referred to areas of 10 cm.² in order to facilitate comparison.

Many of these differences may be readily explainable by the diversities of the experimental conditions and of the methods employed.

However, the data of previous authors and our present findings are in complete agreement with regard to the observation that a given skin area in a given individual will show a relatively constant figure for the "casual level" of ether-soluble substances.

TABLE 2

"Casual level" of ether soluble substances

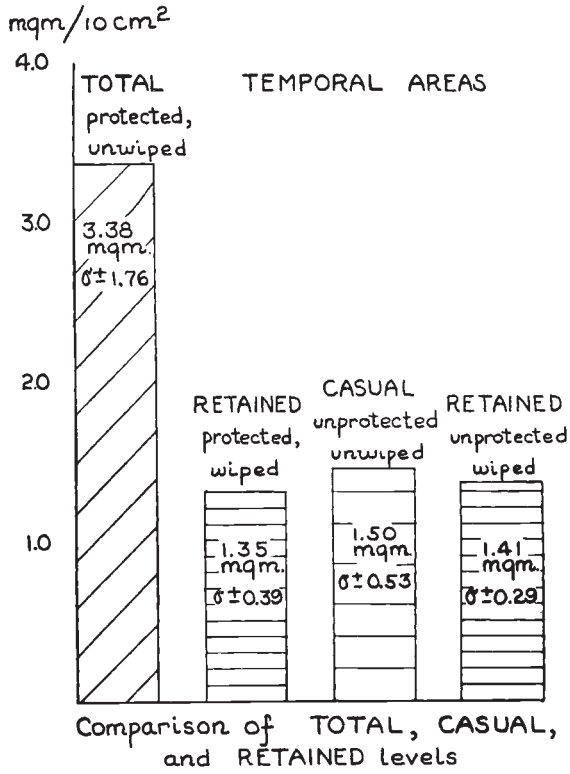
AREA	NO. OF TESTS	NO. OF SUBJECTS	MEAN Mgm./10 cm.^{2}	S.D.
I. Forehead				
a) Center	13	10	2.44	±0.87
b) Temple	97	18	1.77	±0.41
II. Back				
a) In vertebral line				
1. Upper	14	7	1.45	±0.55
2. Lower	8	5	0.73	±0.2
b) Mid-scapular line				
1. Upper	65	23	0.79	±0.32
2. Lower	42	16	0.60	±0.25
III. Chest				
a) Sternum				
1. Upper	9	3	1.28	±0.44
2. Lower	3	2	1.02	±0.22
b) In mid-clavicular line				
1. Upper	61	9	0.99	±0.5
2. Lower	8	7	0.50	±0.014
IV. Shoulder				
a) Anterior	8	2	0.83	±0.28
b) Posterior	1	1	0.70	—
V. Abdomen				
Center	7	3	0.61	±0.14
Hypochondrium				
a. Upper	28	8	0.50	±0.28
b. Lower	6	3	0.38	±0.19
VI. Axilla	2	1	0.5	—
VII. Forearm				
a) Flexor surface	2	1	0.48	—

On the other hand, the "casual levels" were consistently and significantly different on different areas of the body surface. In some confirmation of the observation of S. Emanuel (1), the figures obtained on the mid-forehead, and on the mid-portions of the anterior and posterior trunk were higher than in the more lateral parts. By far the highest levels were found on the forehead—which is also in complete agreement with S. Emanuel's results.

The different body areas tested can be ranged as follows in order of decreasing values obtained for the "casual level": forehead, upper vertebral area, sternal area, upper chest in the midclavicular line, anterior shoulder, midscapular area of the upper back, etc.

The observed *as*ymmetrical distribution of ether-soluble substances in certain individuals must be borne in mind, when comparative studies are carried out. The same observation was made by M. Duenner (7) in the temporal regions of two subjects.

b). *The "total level" (i.e. from sites first protected by a windowed rubber sponge and unwiped).* As illustrated in Graph I, which presents a comparison of the different



GRAPH I

These figures were obtained from three subjects by repeated determinations of all three levels on the same sites.

levels obtained in the temporal areas, the mean "total level" greatly exceeded the mean "casual level." (Quite frequently an oily film was clearly *visible* on the *protected* site before the sampling.) A corresponding difference between "total level" and "casual level" was found on all sites of the body surface in all but one of the subjects tested. This exceptional individual invariably failed to show any significant difference between "total level" and "casual level" on symmetrical sites, or on one and the same area on different occasions.

Discussion

The higher quantities encountered after protection are obviously explained by the exclusion of wiping. It may be surprising that G. Miescher and A. Schoen-

berg (6), with their covering device, obtained figures markedly below our "total level." This was apparently due to the different manner of collecting the specimens (incomplete absorption by filter paper).

c). *The "retained level" (i.e. from either protected or unprotected sites, but deliberately wiped before sampling).* Graph I also shows a mean value obtained for the "retained levels" on the temporal areas. These values were quite regularly exceeded by the "total level." On the other hand, it came to light that there was no significant difference between the "casual level" (preceding *"chance"* removals) and the "retained level" (preceding *deliberate* removal by standardized wipings).

Moreover, the amounts obtained from a given area *after wiping* were essentially the same, regardless of whether that area had been precedingly protected or left unprotected. In either case the levels after wiping were very close to the "casual level."

The differences between the "total levels" and the "casual levels," and of course, also between "total levels" and "retained levels," were observed consistently; and were of a similar order in all areas of the body surface.

Discussion

It is obvious that the "total level" consisted of two parts: One part which was removable with relative ease by wiping, and another which was more adherent and was retained despite the chance or deliberate wipings.

Apparently, the chance but steady removal of the easily removable or "free" part under the ordinary exposures accounts for the relative constancy of the "casual levels" of a given site. The steady chance removal of ether-soluble material from unprotected skin sites also serves to explain the similarity of the "retained level" and the "casual level" from a given site. This same explanation holds for the essentially identical amounts of the "retained levels" regardless of whether or not the area was precedingly protected.

2. *The "Replacement Sum"—(i.e. the sum of values obtained in four half-hourly assays in the two hour period immediately following the removal of either the "total," "casual" or "retained" levels).*

The sum of four amounts collected at the four relatively short intervals of one half hour was greater than the amount obtained in the same total length* of time (i.e. in two hours) without intervening removal of the film.

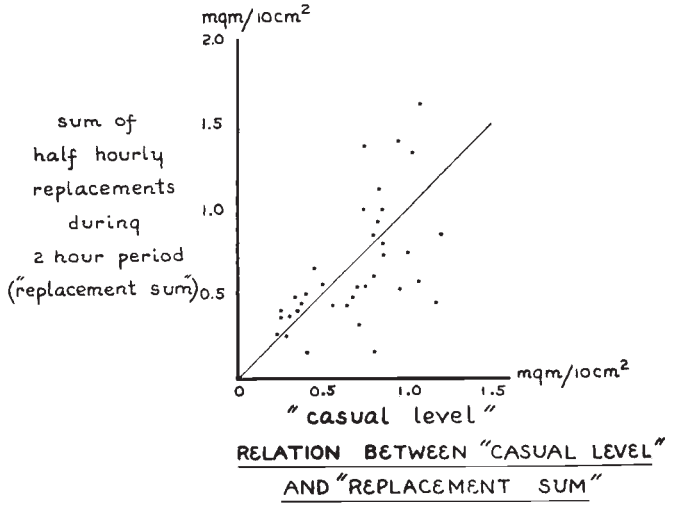
In 88 examinations carried out either on symmetrical sites, or on one and the same site on different occasions, the "replacement sum" was not influenced in any way by the different forms of preceding preparation (protection, etc.) of the particular test site.

No correlation whatsoever was noted between "replacement sum" and the

* This held true also when other time intervals were employed; e.g. the sum of the "levels" collected by us at hourly intervals was less than that obtained in the half-hourly collections, but exceeded the amount obtained after an interval of two hours; and the "total level" obtained after 24 hours was far below the sum which would accrue from the individual collections at shorter intervals.

"total levels." However, Graph II demonstrates that there was a distinct statistical correlation between "replacement sum" and "casual" (or "retained") level. The "replacement sums" are denoted by the ordinate, the "casual levels" by the abscissa. Each point on the graph, therefore, relates the "casual level" to the "replacement sum" obtained at the same sitting, at a given area. It will be seen that most of the points on the graph cluster about the diagonal line denoting equality between "replacement sum" and "casual level." The "replacement sums" were in the majority of instances high when the precedingly determined "casual level" was high, and low when the "casual level" was low.

As a corrollary, if the ratio of the "replacement sum" to "casual level" is expressed as a percentage, this percentage averaged 99.6% in the 36 tests shown in Graph II.



GRAPH II

Each point represents in milligrams the total amounts (sum) of ether-soluble substances obtained in 4 half-hourly collections (ordinate) and the amount obtained in the immediately preceding determination of the "casual level" in the same site (abscissa).

Coefficient of correlation: +0.79; standard error: 0.11.

Discussion

Our findings confirm two observations which were made first by Schur and Goldfarb (12), and which were supplemented directly or indirectly by Emanuel (1), Miescher and Schoenberg (6), Zehender and Schoenberg (9) and Butcher and Parnell (2). The first of these observations is that the *sum of the quantities of ether-soluble substances collected at several relatively short intervals greatly exceeds the amount collected at a single removal at the end of the same total length of time.* The second observation is that once a certain "casual level" has been reached, it remains fairly constant, i.e., there is a "spontaneous" *cessation of further increase in this level.* (Most previous authors have actually dealt with what we here call "casual levels" since they mainly examined "unprotected" skin areas.)

The schedule of four half-hourly collections for a period of two hours was

arbitrarily chosen for determining the "replacement sum", after our preliminary assays had disclosed that the *resultant sum amounted approximately to 100% of the precedingly determined "casual level".*

Regarding the lack of correlation between "replacement sum" and "total level" our findings confirm the observation of Miescher and Schoenberg (6) who routinely applied protection prior to the examinations and could not find a consistent relation between the levels they studied and "production capacity" (which is the equivalent of "replacement sum").*

The same Swiss investigators were able to demonstrate a "very close correlation" between "production capacity" and the "total surface" of the epithelium of the sebaceous glands present. However, our findings—in particular the distinct relationship of the "replacement sums" to the "casual levels" or the "retained levels," and the rapidity of replacement of these levels—suggest that there also exist other physiologic mechanisms which regulate the replacement. This assumption is supported also by the observation of E. O. Butcher and A. Coonin (3) that the viscosity of sebum increases through cooling on the skin surface and thus inhibits further "exudation."

The hypothesis is herewith submitted that saturation of the uppermost stratum corneum with ether-soluble substances is maintained, *not only by the activity of the sebaceous glands, but also by other factors such as the capacity of the superficial horny structures to take up lipids, the presence of lipid-emulsifiers, the increased viscosity of the surface-film, etc.* Characteristic individual and local combinations of these factors would account for the characteristic limitation and relative uniformity of the amounts of the "retained" and "casual levels" and of the "replacement sum" of a given site. Such determining local factors would also account for the fact that removal of the extruded, easily removable, surface film of ether-soluble substances fails to exert a significant influence upon the rate of replacement.

PART II

Relationship Between Delivery of Sweat and Quantity of Ether-Soluble Substances.

In all areas except for the mid-forehead and the axillae, the described regional variations in the level of the ether-soluble substances strikingly *paralleled the regional variations in sweat delivery*, as recently demonstrated in investigations at the Skin and Cancer Unit. (Details of these further studies on sweating will be reported elsewhere.) Most convincing and striking was the finding that in those cases in which the quantities of ether-soluble substances *differed* in symmetrical sites, these differences *were paralleled by the corresponding differences in sweat delivery.*

* We have preferred the term "replacement sum" to "production capacity" (6–9), because there is no evidence that the removed ether-soluble material is replaced only and entirely by material *newly* produced by the holocrine sebaceous glands. The rapidity of replacement and its correlation to the "casual level" and the "retained level" rather suggest that the replacement mechanism may include a participation of preformed material coming from depots or reservoirs (e.g. in the glandular ducts) and various factors accelerating the extrusion of such material.

In order to obtain further information on a possible relationship between sweat delivery and the level of ether-soluble substances, we carried out numerous assays on the palms, where sebaceous glands are absent, but where sweat glands are abundant.

Thirty-five assays of the "casual level" on the palms revealed an average of 0.37 mgm of ether-soluble substances per 10 cm.²†

The "replacement sum" in the palms did not differ in symmetrically situated sites. The sum of the amounts collected at four half-hourly intervals averaged 0.12 mgm/10 cm.²† When the "replacement sum" was compared on the two palms of a subject whose one hand had been prepared by any of the precedingly outlined methods, designed to prevent contamination of the palms with sebaceous material from other skin areas, no significant differences were discovered.

The "replacement sum" invariably increased after exposure of the palms to dry heat, subsequent to removal of the original film of ether-soluble substances. This increase was unaffected by any of the procedures designed to prevent contamination of the palm with sebaceous material from other skin areas. After exposure to heat, the "replacement sum" averaged 0.19 mgm/10 cm.²†

DISCUSSION

These results indicate that small, but nevertheless significant amounts of ether-soluble materials were present on the palms, even when measures were used, designed to prevent contamination of the palmar surfaces by sebaceous material from other areas.

The findings can hardly be reconciled with the conclusion at which Emanuel (1) arrived from his examinations of the palms and soles, namely that the amounts of ether-soluble material found by his method of collection (glass-receptacle) are "produced by sebaceous glands", and that "the shares contributed by the epithelium and sweat" are negligible. Our observations would also appear to be in some disagreement with Miescher and Schoenberg's similar statement that the sweat can be neglected as a factor in quantitative examinations of the ether-soluble film on the skin (6).

At any rate, our observations seem to revive the old controversy (13, 14) as to whether or not fats are preformed components of the sweat. As was pointed out by Rothman in J. Jadassohn's Handbook (15), ether-soluble substances *might* pre-exist in the sweat, but they are known to be present also in the lamellae of the stratum corneum. It appears to us that such substances could enter into emulsification with the sweat. However, an exact decision on whether fats are preformed components of the sweat, or are found in sweat but are derived from other sources, will not be possible until analyses can be made of sweat obtained by direct catheterization of the sweat ducts.

It appears to us that our results support the opinion of Rothman (15), that

† All our collections in the palms (just as the collections on most of the other test sites) were carried out on areas of 20 cm.²; the weights obtained, therefore, were actually twice as high as those presented, and remote from the range of technical fallacy.

the *custom of identifying the total of ether-soluble substances on the skin entirely with sebaceous products*, is at present not acceptable.

Our findings on the palms indicate that the sweat in some manner participates in the process of accumulating ether-soluble materials on the surface of the skin. However, judging by our assays on the palms and the other body surfaces, the relatively small amounts of ether-soluble substances which might be contributed by sweat itself or by any other material not coming from the sebaceous glands would not fully explain the great extent to which experimentally induced sweating apparently augments the amount of surface lipids. We believe that the *great increase in surface lipids subsequent to sweating* may best be explained by an *emulsifying interaction between sebum and sweat.* This view is supported by the results of certain as yet unpublished experiments shich we have carried out to study the emulsification of ether-soluble substances of human skin. The concept is further strengthened by the following observations:

a) by the parallelism we have demonstrated in the quantities of ether-soluble substances and in the quantities of sweat delivered in various regions on the body surface.

b) by the apparently parallel changes in the outpouring of sweat on the skin's surface and in the level of ether-soluble substances on the skin, under the influence of such factors as changes in environmental temperature, relative humidity, ventilation, air pressure, etc.

c) by the demonstrated great speed of replacement of the ether-soluble film, as well as the rapid spread of sebum from the follicular openings through the sulci on the skin surface (demonstrated by Butcher and Parnell (2)). It is our opinion that these observations are more readily explained by an emulsifying action of the sweat, than solely and entirely by the low viscosities of the freshly produced sebum (Butcher and Coonin (3)).

The *physiologic and clinical importance of a close relationship between the levels of ether-soluble substances and of sweat secretion is obvious.* For example, such relationships might well be of critical influence in the fluctuations and pathogenesis of the seborrhoic dermatoses, of ichthyosis, of atopic dermatitis and many other common dermatoses.

SUMMARY (PARTS I AND II)

1. A relatively convenient and satisfactory method is described of collecting the ether-soluble film on the skin and of assaying its amount.

2. The amount of ether-soluble substances collected from sites unwashed and not artificially protected against the ordinary repeated chance removals is herein designated as the "casual level."

The "casual levels" were relatively consistent at a given site in one and the same individual. However, there were consistent and significant differences of this level on different areas of the body surface.

Three of the 32 test subjects showed a consistent difference in the "casual levels" in symmetrical areas.

3. The amount of ether-soluble substances obtained from a site protected

against contact and chance removals by a windowed rubber sponge held in place for a period of 24 hours, is herein termed the "total level." The "total levels" were considerably greater than the "casual levels" in all areas tested.

4. The amount of ether-soluble substances obtained after the sites were wiped with dry muslin in a standardized manner, is herein designated as the "retained level." This level was uninfluenced by preceding protection. The *"retained level"* was invariably far below the "total level," but *not significantly different from the "casual level."*

5. These results indicate that the "total level" consists of one part removable by wiping, and another retained despite the wiping. Moreover, they suggest that the close quantitative correspondence of "casual levels" and "retained levels" may best be explained by the assumption that ordinary and chance contacts steadily and consistently remove from the skin's surface a relatively easily removed portion of ether-soluble substances.

6. Assays of the "replacement sum," (i.e. the sum of four consecutive half-hourly collections of ether-soluble substances, the first collection being made one half hour after a complete removal of the ether-soluble substances in the fashion described), brought to light a significant correlation between this sum and the "casual level" or "retained level," but not between the "replacement sum" and the "total level."

7. Ether-soluble material was *demonstrated on the palms*, even after their surface was prepared with procedures designed to reduce or exclude contamination with sebaceous products from other skin areas. Exposure of the palms to *dry heat promoted* the delivery of ether-soluble substances.

These and other findings suggest a definite *enhancing effect of the outpouring of sweat on the quantity of the ether-soluble film on the skin's surface.* This effect apparently occurs in all areas of the skin surface. It can, in our opinion, be adequately explained as due to an *emulsifying action of the sweat on the lipids* of the skin.

8. A relationship between the amount of ether-soluble film on the skin's surface and the amount of secretion of sweat is obviously of great physiologic and clinical interest. It is especially important for the dermatologist in connection with its possible significant role in so-called "dry skin" and in the pathogenesis and course of certain common dermatoses.

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